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## **Philosophical Transactions**

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other ) furrows be made : For, Experience hath taught us, that the Land laid up without furrows bears more Corn, than that which hath more furrows ; because the Wheat and Barley, and other Plants receive greatest damage by drought : And therefore this ought more especially to be observed in *Spain*, one of the dryest Country of *Europe*.

12. In many parts of *Spain* in 1664. it was found, that Land sown in *September* hath yielded a better Crop, then that which was sow'd in *October*; and that sown in *October*, better than that sown in *November* : Which proveth, that 'tis more advantageous to sow early, then late.

13. They have observ'd also, That it is very profitable to sow in the *New Moon*, because it will shoot forth, and thrive, and ripen sooner. This is understood for those, who till but a little Land, and so can chuse their own time to sow ; but those that plough great quantities, can lose no time nor season in sowing. And in *Spain* they may begin the first *New Moon* in *September*, and so go on, and end with the *New Moon* in *November*. And in *Italy* they may do in the same manner, as also in the Islands of the *Mediterranean*. But in *Germany* and the *Low Countries*, they begin in the end of *August*, and end with the *New Moon* of *October*.

*So far this Account.* If any desire to see this *Instrument*, he may inquire for the *Curator* of the *R. Society* (Mr. Hook,) or for their *Operator* Mr. *Shortgrave*, in *Gresham Colledg*, the latter of whom will also, in all likelyhood, be ready to provide the *Engine* itself for those, who shall please to make use of it.

*An Account of the Observation, made by the Philosophical Academy at Paris, May 12 1667 about 9. of the Clec<sup>ks</sup> in the morning, of an Halo or Circle about the Sun; together with a Discourse of M. Hugens de Zullichem, concerning the Cause of these Meteors, as also that of Parelia's or Mock-Suns. Englished out of French by the Publisher, to whom it was sent but lately from the worthy Author of the said Discourse.*

THE Diameter of this Circle, which was exactly observ'd, was found to be of 44 degrees, and the breadth of the Limb thereof, of about half a degree. The upper and lower part were of a vivid red and Jellow, with a little purple-colour

lour, but especially the upper; the red was within the Circle. The other parts appeared but whitish and of little clearness. The space within the *Halo* was a little darker then that about it, especially towards the parts that were coloured. Besides there was seen the portion of another great Circle, which touched the *Halo* above, and whose extremities were bent downward, as is represented in the I. *Fig* in Tab. 2. This portion of a Circle had also its Colours like those of the *Halo*, but fainter. The height of the Sun, at the beginning of the Observation, was about 46. degrees. There were in the Air little white Clouds, which somewhat tarnish'd the blew colour of the Heavens, and lessened the brightness of the Sun, which shone as in an Eclipse. The weather was cold, considering the season of the year, and it was affirmed for certain, that it had frozen the night before. This *Halo* appeared in the same beauty and splendor of colours, unchanged, from 9. in the morning, (when it began to be observed) until about half an hour past ten; after which time it became fainter and fainter till two of the clock in the afternoon, when it ended, after it had resumed a little more force some time before it disappeared.

The Observation of this *Phænomenon* engaged M. *Hugens* to propose to the Company, assembled at his Majesties Library, what he had meditated, some years agoe, concerning the Cause, not only of these *Halo's*, but also of the *Parhelia*, which have been hitherto look't upon by many as Prodigies, and as Prognosticks of some singular Event.

As for the *Halo's*, he said, that they were formed by small round grains, made up of two parts, one transparent, the other opaque, the latter being inclosed in the former, as a cherry-stone is in a cherry; as may be seen in the II Figure, wherein A A represents one of these grains, and B the kernel or opaque part ('Tis drawn much bigger than the natural, to render the thing the more intelligible.)

He related the Observations of those who have seen *Hail* formed after this manner, and, among others, that of M. *Des-Cartes* in his Treatise of Meteors; and explain'd, how that some of these little grains, which swim up and down in the Air betwixt us and the Sun, being less distant from the *axis*, which  
extends

extends itself from the Sun to our Eye, than of a certain angle, do necessarily hinder the rays, which fall on them, from coming to our Eyes, in regard that the opaque kernel is the cause that there is behind every such grain a space of a conical figure, as  $MNO$  in the II. Figure, in which the Eye of the Spectator being situated cannot see the Sun through that grain, though it may see him when posited elsewhere, as somewhere in  $P$ .

And to make the Company the more distinctly to understand the effect, which these Grains suspended in the Air must produce, he drew the III Figure; in which,  $B$  is the place of the Eye;  $BA$ , the axis which passeth from the Eye to the Sun;  $C, M, F$ , some of the icy Grains with their kernel making them half opaque: Among which, the Grain  $C$ , being in the axis  $BA$ , and the lines  $CK, LH$ , representing the rays of the Sun nearest to the axis, the passage of which is not hindered by the opacity of the kernel, 'tis certain, not only that the grain  $C$  will not be able to transmit any ray of the Sun towards  $B$ , but also that, imagining the superficies of a Cone, whose top is in the Eye, and its sides  $BD, BE$ , parallel to the rays  $CK, LH$ , all the grains  $MM$ , which this superficies shall comprise, will likewise not suffer any ray to pass to the Eye, because it must needs be in their Cone of obscurity; but those, that shall be without this superficies, as the grains  $FF$ , will let them pass, because the Eye is without their Cone of obscurity. Whence it follows, that the Angle of this Cone  $BDE$  is that, which determines the Diameter of the *Halo*, which depends from the proportion, the opaque grain hath to the transparent, in which it is inclosed. For, if this Diameter is of 44 degrees, as is observed in most *Halo's*, the bigness of the opaque grain will be to the transparent as 40 to 19. But he said, that this proportion was not always the same, and that the diversity of it was the cause, that sometimes there were seen many *Halo's*, one about the other, all having the Sun for their Center.

He added, that it was easy to know, why these *Halo's* were always of a round figure, whether the Sun be little or much raised above the Horizon; as also to give a reason of their Colours, which is the same with that in the Triangular Glasses;

Prisms;

Prismes; as is evident by the *Tangents* A D, drawn to the Grain A, at the points, where the Ray D A enters or comes out.

Further he took notice, that it was also manifest, why the *red* colour is in the interior circumference of the *Halo*. And why the space, which it taketh in, and chiefly near the most lively colour'd parts, appears obscurer than the Air about; *viz.* because 'tis there, where *most* Grains are, which transmit no rays of the Sun to our Eyes, and so do nothing but darken the Air, as the drops of water when it raineth.

Moreover he noted, that M. *Des Cartes*, endeavouring to explain the Cause of these *Halo's*, had committed a mistake, for want of Observations, truly relating this last circumstance: Because he maintains, that the space comprised within the *Halo* is clearer than the Air without; and to render a reason of it, he supposeth certain Grains, *altogether* transparent, having the form of a lentil; which supposition cannot therefore be true, because what he deduceth from it, is contrary to what is observed: Besides that the roundness of the *Halo* in all the elevations of the Sun agreeth not with it, as were easy to show.

He stay'd not to examine the Generation of the half-dark grains, because he is shortly to publish a larger Treatise of this subject; where he intends also to render a reason, why the dark kernel keeps certain proportions, rather than others, with the Grain, which contains it.

As to the Arch of the Circle, which above touch'd the last *Halo* seen May 12th, as also that the Colours were more vivid in this place, and in that below, then in the rest of the Circle; he said, that these effects did not proceed from the Grains, he had been speaking of, but from another cause, which did also serve for the production of the *Parhelia* and the *Circles* which almost always accompany them.

Tou'ching which *Circles* and *Parhelia's* he told the Company, that besides the round and half-dark Grains, there were also formed in the Air certain little Cylinders of the like nature, and of which M. *Des Cartes* himself declared in his *Treatise of Meteors* to have observed some, not indeed with opaque kernels  
within,

within, but that the same cause, which produceth them in the round grains, could also produce them in Cylinders: Which being supposed to be such as the IV. Figure represents them, viz. oblong icy grains, and roundish at both ends, having the inner kernel of the same shape, it was found, that from their different dispositions all the appearances of the *Parhelia* and their *Circles* did necessarily follow.

And first, that some of these Cylinders being erect, in the situation which probably they ought to have in being formed, there must appear in the Heavens a great white Circle, parallel to the Horizon, passing through the Sun, and of near the same breadth with him; as hath been observed in the *Phænomenon* of Rome A. 1629. of which *Gassendus* and *Des-Cartès* have written, and which is here exhibited in the V. Figure. That this Circle L K N M is caused by the reflection of the rays of the Sun upon the surface of these Cylinders; it being easy to demonstrate, that there are none but those, which are raised at the same angle above the Horizon with that of the height of the Sun, that can reflect his rays to our Eye. Whence it manifestly follows, that it must appear White, and throughout of equal altitude with the Sun itself, and by consequence parallel to the Horizon. That considering afterwards the Transparency of these perpendicular Cylinders, and their opaque kernels, it is easily seen, that those of the white Circle, which are distant from the Sun at a certain angle, begin to give passage to his rays to strike our eyes, in the same manner as hath been said of the round half-dark Grains. That these Cylinders are those, which on each side of the Sun make us see a *Parhelion* in the great white Circle, as hath been noted in the Observation of Rome (where they are mark'd with K and N) and in many others. That these *Parhelia* have commonly luminous tayles, because the Cylinders, which follow those first ones that form the *Parhelia*, and which are yet further distant from the Sun, let also pass his rays to our Eye, so that these Tayles may be 20 degrees and more in length. That the same *Parhelia* are always colour'd, because they are made by refraction, as the *Halo*.

That besides, there are two other Images of the Sun, generated

rated by these perpendicular Cylinders, and so disposed in the great white Circle, that the Spectator, turning his face towards the true Sun, hath them behind him; as in the Roman Observation are the *Parhelia* L and M. That these are produced by two refractions and one reflexion in these Cylinders, in the same manner as the ordinary Rain-bow in the drops of water, according as M. *Des-Cartes* hath declared: So that the opaque kernels do nothing to the production of these two Suns, but that they may be sometimes so big, as to make them not appear.

*That* according to the Altitude of the Sun, more or less, these two *Parhelia* are more or less nigh to one another; of which he promiseth to give the true measures in his Treatise of *Parhelia's*.

*That* they should appear coloured, as the Rainbow, and that sometimes they have been seen such; but that when they are faint, they may also seem white, even as the *Halo's*, when they are not very bright.

*That* these same perpendicular Cylinders can also produce an *Halo* about the Sun, by reason of the rounding of their two ends; which maketh, that being distant from the Sun at a certain angle, on what side soever it be, they begin from thence to give passage to the rays, transmitting them to the Eyes of the Spectator. And *that* these *Halo's* are probably those, we see almost always pass through the two *Parhelia* that are on the side of the true Sun, as the *Halo* G K N I in the Phenomenon of *Rome*.

*That* there is yet an other situation of these Cylinders very considerable, which is of those that are couchant, so as their *axes* are parallel to the plan of the Horizon, but turn'd divers ways, some one some another way, like needles confusedly thrown on the ground: Which Horizontal disposition is very natural to those Cylindrick Bodies, supported by the vapors, which rise from the earth, as may be made out Experimentally in Bodies thus figur'd, being let fall in the Air.

*That* it is in these Cylinders, that the *Arches*, which touch the *Halo's* above or below, are formed; such as there were in the *Phænomenon* observ'd at *Rome* A. 1630. which is described



bed by P. *Schenir* in a Letter to M. *Gassendus*, as also in all those, which M. *Hevelius* hath related at the end of his *Mercurius in Sole*. And that the Arch, which appear'd upon this last *Halo* at *Paris*, was of the same kind. That the figure of these Arches is different according to the different Altitudes of the Sun, and the several Magnitudes of the Diameters of the *Halo's*. That when the Sun is very nigh the Horizon, such an Arch appearing upon an ordinary *Halo* of 44 degrees, must represent as twere two Horns, as in the VI. Figure, A B, A C: But that the Sun rising higher, those Horns become lower in proportion, and make such Arches as are represented in the same V I. Figure, where each height of the Sun is mark'd near the Arch, which it is to make: Of which the Demonstrations were reserved to the same Treatise of *Parhelia's*

That the place of the Arches where they touch the *Halo's*, being more strongly enlightened and coloured than the rest, maketh us Judge, that there are *Parhelia* in those places.

That the reason, why these Arches do ordinarily touch a *Parheliion*, was, that the same Cylinders couchant, which produce the Arch, produce also that *Parheliion*, by the means of their two round and transparent Ends, in the same manner as hath been said of the perpendicular Cylinders. And that the *Parheliion* last seen at *Paris* had been formed in these couchant Cylinders. That that was also confirmed, by reason that it was brighter in the superior and inferior part, than any where else; which necessarily coms to pass in a *Parheliion* caused by Cylinders thus disposed, whereas when produced by the round Grains, it must appear every where equally strong.

That in these same Cylinders parallel to the Horizon, there is also found the Cause of the *White Cross*, observed together with the *Paraselenes* or Mock-moons by M. *Hevelius*, and exhibited at the end of his *Mercurius in Sole*: the perpendicular *Fillet* of that Cross, coming from the reflection of the rays of the Moon upon the surface of these Cylinders; as the other *Fillet*, parallel to the Horizon, is produced by the reflection of the perpendicular Cylinders which make the great white Circle, of which this *Fillet* is a part. That yet the Moon must not be very high above the Horizon, to the end that the cou-

ching Cylinders may produce this effect: And that it should be well heeded, when the like Meteor shall appear, whether the perpendicular Fillet be not narrower where it passeth through the Moon, than in other places, and especially upwards, where it must grow larger and dis-appear.

*That* besides the perpendicular Cylinders, and those that are couched parallel to the Horizon, there are often a great many, which move to and fro in the Air in all sorts of positions; and *that* those, by the same reason that the round Grains do, must produce an *Halo* about the Sun, and even a more vivid one than that which is caused by the Grains, forasmuch as each Cylinder sends many more rays to the Eye, than each of these little Spheres. *That* the little Halo D E F, in the Roman Phenomenon ( *Fig. V.* ) may very well have been caused by such Cylinders.

As to those Mock-suns, which sometimes show themselves directly opposite to the True Sun, ( such an one as was published by M. *Hevelius*, and observed *Febr. 23. 1661*; ) *that* he could find nothing neither in the round Grains nor in the Cylinders, which should make these Suns necessarily to meet in the great White Circle, parallel to the Horizon, and *that*, if that should be always verified by future Observations, the cause of it must be sought for elsewhere: But that in the mean time he did believe, that that hapned not but by chance; which being so, a reason might be given of these Suns by the same supposition, which served also for the *Anthelion*, observed by M. *Hevelius* *Sept. 6. 1661*; in which there were two coloured Arches of a Circle, opposite to the Sun, which did intersect one another, their intersection being the place of the False Sun. Which although it be represented in the Figure of *Hevelius* at the same height with the true Sun, yet it was in truth higher by 15 degrees or more; as he hath acknowledged himself afterwards: So that, if there had been a great white Circle in this Phenomenon, the *Parhelion* was not at all to have been in it.

*That* for the generation of these Suns, he did suppose a number of small Cylinders with opaque kernels, as the precedent; which were carried in the Air, neither perpendicularly, nor couching

ching, but inclined to the Plan of the Horizon at a certain angle being near an half right one; to which were particularly appropriated those Cylinders, which M. *Des Cartes* saw fall from the Heavens, having Stars at both ends: As may be seen experimentally, by forming Cylinders of that fashion, which is represented in *Fig. VII*, and letting them descend in the Air or in Water. *That* in these Cylinders was found, following the *Calculus* to be given in the Treatise of *Parhelia's*, not only the Cause of the *Anthelia* made by the intersection of two Arches, as in *Fig. VIII*, but also that of some other Extraordinary Arches and Rods, that are sometimes observed near the Sun, of which notwithstanding there could nothing be as yet affirmed with certainty, for want of exact and faithful Observations.

To make all these different effects of the Cylinders manifest to the Eye, M. *Hugens* produced one of Glass, a foot long, of the shape of that in *Fig. IV*; and for the kernel opaque in the middle, a Cylinder of Wood, and the ambient space filled with water, instead of transparent Ice: Which Cylinder being exposed to the Sun, and the Eye put in such places as was requisite, there were successively seen all those reflexions and refractions, that have been discoursed of. Whence it might be concluded, that a great number of the like Cylinders, although very small in comparison to that, being found in the Air, and having the several postures that have been supposed, all the Appearances of the *Parhelia* and their Circles must exactly follow.

It was wished, for an entire confirmation of the truth of this Hypothesis, that some of those small Cylinders could be observed to fall to the ground at the time, when any *Parhelia* do appear: Which he showed could not easily be done, because that the vapors, which then rise from the Earth upwards, and which are the cause of their Cylindrical figure, keep them also suspended in the Air. He added, that it was not to be thought strange, that such small grains of hail were thus kept up in the Air by the vapors, forasmuch as these, by being rarified and dilated upwards, might have motion enough for this effect. *That* that was more easy to conceive, than to imagine, how these same

vapors could keep suspended a very great and weighty Circle of Ice, such as M. *Des-Cartes* supposeth to explicate the cause of *Parhelia's* and of the great White Circle of the Roman *Phanomenon*. In which supposition were also to be noted the following difficulties; *viz.* *That* therein there appears no reason, why the White Circle should pass through the Sun, as is always observed, and that it should shade him according as he changes in height, though the *Phanomenon* do sometimes last three or four hours: *That* this same White Circle, formed of Ice, being seen by Spectators distant enough from one another, could not appear round to all ( as it doth ) and to traverse the Sun: *That*, when *Parhelia* are observed, there appears not at all this round Cloud encompassed with the Icy Circle, which by its thickness should hide a part of the Heavens; but that the Weather seems almost altogether serene, there being none but small clouds, which are seen to change places, whilst the great Circle and the *Parhelia* remain at rest. *That* in this Hypothesis it happens not but by chance, that the *Parhelia*, which are at the side of the Sun, appear in the Intersections of an *Halo* and of the great White Circle; which yet is observed to come to pass always, and shews, that the Causes of these *Halo's* and of the *Parhelia* are very little different, against the opinion of M. *Des Cartes*.

*A Discourse of Dr R. Wittie, relating to the Notes of Dr Foot in Numb. 52. and to those of Dr. Highmore in Numb. 56. of these Tracts; concerning Mineral Waters, and Extracts made out of them: Communicated to the Publisher, by way of Letter.*

Sir,

I Must always acknowledg myself much obliged to you for the reiterated mention you have been pleased to make of my Book in your *Transactions*, and your patient condescension to the trouble, that hath ensued therefrom to you, whereas I could not have any ground of hope, that any thing of mine should have fallen under your notice. And this goodness of yours gives me encouragement to presume at this time to desire your favor in the perusal of these lines, which are occasioned

